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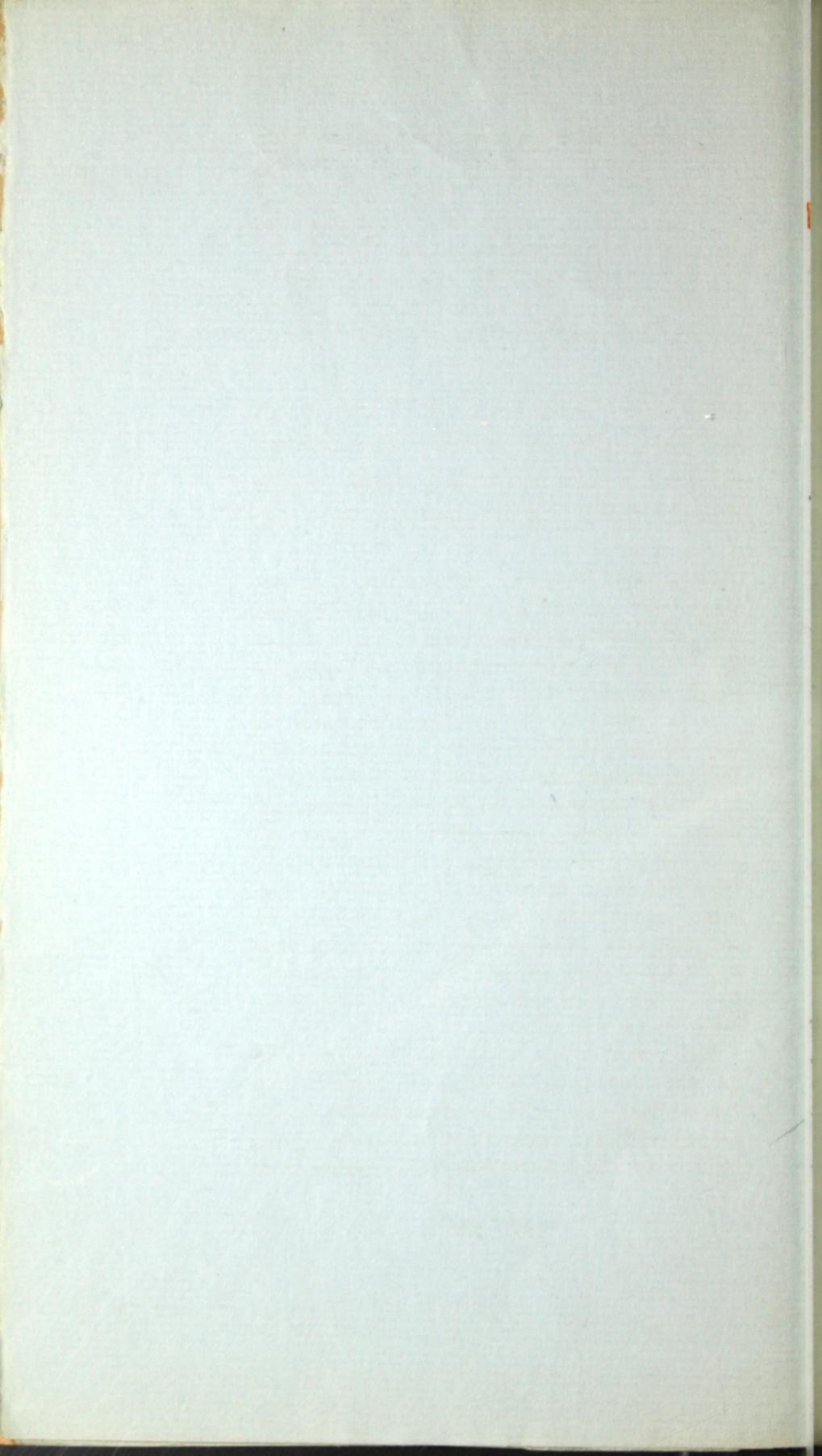
The Story of the Design,  
Installation and Operation  
of the Electrical Apparatus  
of the Open Air Theatre  
at Longwood

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## DESIGN, INSTALLATION AND OPERATION OF THE ELECTRICAL APPARATUS OF THE OPEN AIR THEATRE AT LONGWOOD

**T**HE OPEN AIR THEATRE at Longwood was first constructed in 1912 and was used for many years with a semi-portable type of footlights and other stage equipment controlled by a small bank of dimmers.

In 1926 Mr. P. S. du Pont's ideas of more elaborate lighting arrangements became clear enough that he decided to re-vamp the entire theatre layout. In addition to the regular theatre equipment he visioned some electrically lighted and operated fountains both on and about the stage, controlled from a point out in front of the stage where the operator could see clearly the effects he was producing. He visioned dressing rooms under or in back of the stage and a room under the stage floor where pumps and other necessary machinery could be installed.

To transform his ideas into actualities Mr. du Pont assigned to Rowland W. Taylor, Civil Engineer in charge of the Construction Division of Longwood Farms, the work of making the layout, constructing the concrete and steel structure which

is mostly under ground and restoring the exterior of the stage to its original appearance. To Russell P. Brewer, in charge of the Maintenance Department of Longwood Farms, was assigned the task of experimenting, designing and installing the electrical apparatus. It is upon this part of the work we will dwell here.

In September 1926 a visit to several mid-western cities was made in an effort to see some colored fountain installations and accumulate ideas. The result of this trip was the learning of several ways not to build them which of course directed thought to other and newer ways for experiment. The old arc-light type of lighting was being cast into discard and the incandescent lamp taking its place.

The problems of directing and controlling the beam of light needed solving—various types of reflectors were tried as well as various points of location of the lamps. The problems were so interesting that everyone connected in any way with the project became interested and many offered valuable assistance. May it here be said that Geo. S. Grossman—the representative of Rumsey Electric Co. of Philadelphia kept closely in touch with the work as it progressed and was of great help in many ways—from the introducing of Mr. Scholl of the Holophane Co. into the picture to the tracing of an express car load of dimmers from Cutler Hammer Mfg. Co., Milwaukee, Wis., to Wilmington, Del. George was always ready to get anything in the electrical line and usually got it.

Mr. Scholl decided after hearing the story that a new type of plate lens would give the results desired so he requested David H. Tuck, Chief Engineer of the Holophane Co., and Harry I. Day, Consulting Engineer with Kirby, Inc., to study the problem.

The type of light unit finally adopted as the best is a modified Kirby-Lite using two plate lenses,

designed by Mr. Tuck, consisting of concentric circular prisms throwing a 45 degree angle beam of concentrated light—the other lens consisting of parallel prisms so arranged as to elongate the circular beam of the other lens into an ellipse. The reflector in back of the lamp is of the Roundel type of Bausch and Lamb manufacture and is scientifically and accurately made. The color filters selected by Mr. Day are also of the Roundel type and are true colors made by the Corning-Glass Co. The lamps—made at Nela Park—are of the projection type—concentrated filament with pre-focuse base and in wattages varying from one to five hundred. To more nearly equalize the intensities the reds have 100 watts while the blues and greens have 200 watts.

The colors desired in the foot-lights were red, blue, green, amber, flesh-pink and moon-light, while the colors desired in the water curtain and fountains were red, blue, green and white. For these reasons the light units were made up in groups of four and six units in a line.

The way of getting the light from the source to the water and obtaining the best color effects required considerable figuring and experimenting. It was discovered that the best results were obtained when the light source was from beneath and from the opposite side of the water from the spectator. Mr. du Pont's ideas about a water curtain proved to be both reasonable and practical with the results as may now be seen. The window idea in a sheet metal trough worked out equally well for both the water curtain lights and the foot lights.

The way of lighting the circular fountains on the stage floor offered more of a problem but through the good offices of Clinton Brown, representative and Wilbur Jones, Vice-President of the Delaware Electric & Supply Company of Wilmington, Del., a

type of cast iron basin with windows in the circumference at an angle to permit the directing of the light beams from below was devised and a foundry located that would make them. It was also necessary to have covers that would fit over these basins so as to make the stage floor perfectly smooth and flat for regular theatrical performances; these covers are made of sheet aluminum in sectors of the circle and fit so neatly that small holes drilled in them permit the fountain jets to shoot up through when desired. These cast iron basins weigh about 3000 pounds each and are supported on a central pillar as well as being tied into the slab of the stage floor. The fountains on the upper level, or what we call the Upper Basins, are lighted in a similar way to the water curtain and stage fountains.

The determining of the correct height of the various fountains was almost impossible, therefor in the selection of pumps ample allowance was made to permit the adjusting to the desired height by means of a bypass from the discharge to the suction of each pump. This was where G. W. C. Fry of the Allis-Chalmers Company came into the picture and aided in the selection and supplying of pumps and motors of the same make as those used in our Water Garden. A two section reservoir from which the pumps draw the water is located directly under the water curtain trough and all of the fountains drain into it. Its capacity is about 2500 gallons and the water returns quickly enough to permit of the continuous use of as large a display as is usually desired. Nine centrifugal pumps are located directly under the stage and supply all of the fountains excepting the two isolated ones on the roofs of the small houses on the East and West sides of the stage which circulate the water in their individual basins. The switch board containing the starters for all of the pump motors also is located

under the stage together with the blowers for ventilating the dressing rooms, the frigidaire units for removing the moisture from the circulating air and the boiler and oilburners for warming the air and the electric heaters for heating the water used in the showers and lavatories in the dressing rooms.

The general lighting of the dressing rooms is done with Holophane Filter Lites while the make-up lights consist of six small lamps placed three on each side of each mirror.

To make the play of colored light on fountains pleasing it is necessary to have complete control of the intensity and to do this, remote controlled dimmers were essential. G. E. Hunt of the Cutler-Hammer Mfg. Co., worked with us on this and together with the engineering department of his company we were able to obtain an arrangement that has proven entirely satisfactory. The dimmer for the fountain lights are entirely motor operated. In as much as the lighting circuits of the water curtain and similar circuits of the footlights were identical as to capacity, a way was devised to use the same dimmer plates for both especially as they were never required to be on at the same time. This was accomplished by the use of interlocking magnetic contactors and the motor operation with remote control and hand control of the dimmers on these circuits.

The switchboard controlling the theatre lighting is located in a small building to the West of the stage and in a position so that the operator has a clear view of a large part of the stage. All of the switches have indicating lights as to the color of the circuit they control as well as a pilot light that shows when the circuit is on or off. These switches control magnetic contactors and are in turn controlled by a master switch which permits the complete blacking out of all lights or the flooding of the

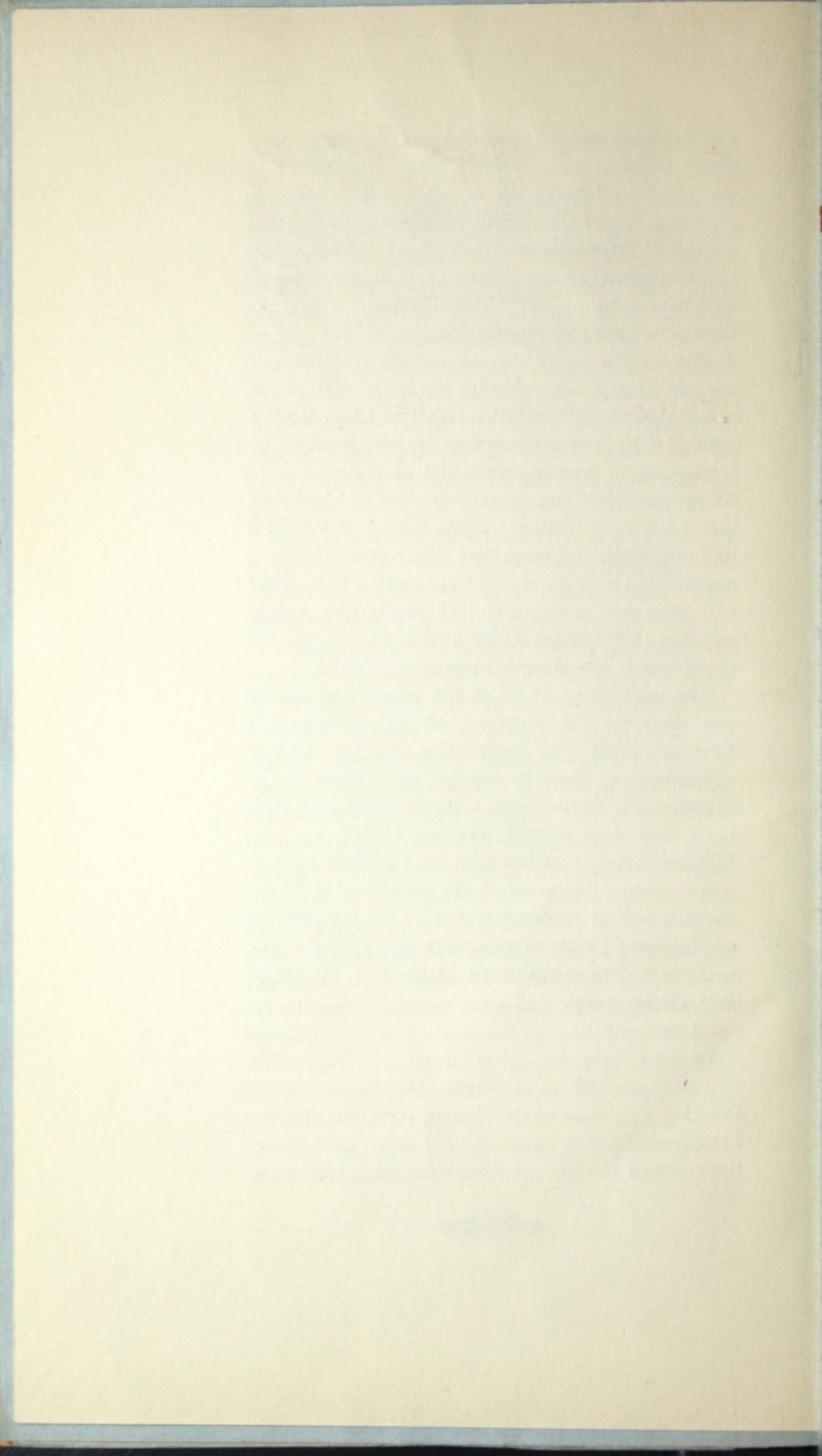
stage with light. In this same building is located all of the apparatus controlling the lighting of both the stage and fountains. There are two banks of dimmers, two boards on which are mounted one hundred and twenty magnetic contactors, a power board containing the main feeder switches, the stage control board above mentioned and three banks of transformers consisting of three 100, three 25 and two 15 Kv. A., units, and the twenty-three hundred volt oil switch and meter panel. The total connected lighting load is 125 Kw., and the total power 71 h.p. The space for all of this apparatus was limited to this building and the layout as now installed has been called a model of compactness.

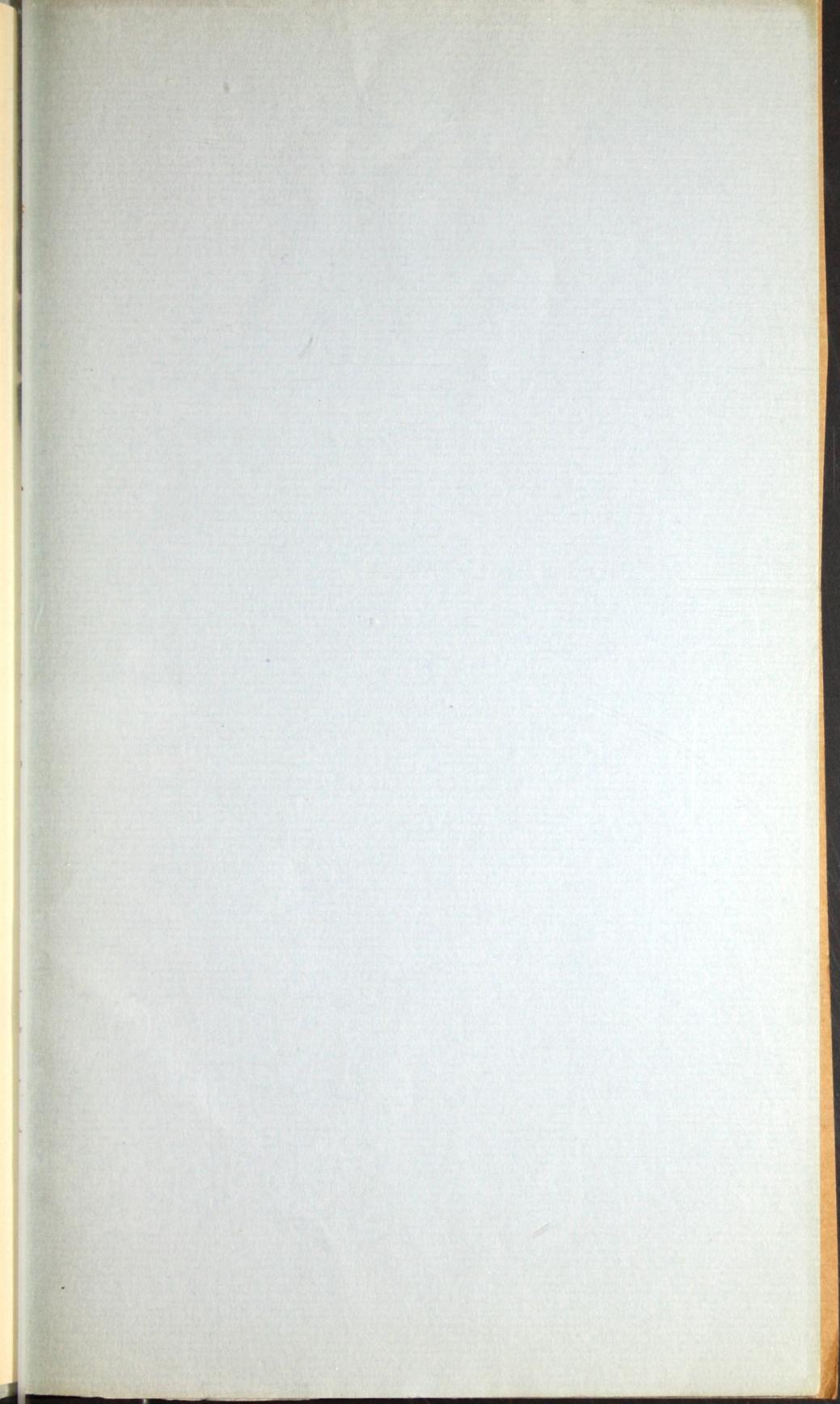
Next we come to the remote control panel located in the spotlight tower in the back part of what would be the auditorium of an indoor theatre. This panel is unique in both its design and the scope of its control. There is marked out on the panel the stage and surroundings showing the location of all of the fountains and in accordance with Mr. du Pont's request, the switches controlling the various fountains are located as near as possible to exact fountain they operate. As near as possible the left side of the board contains the switches controlling the lights while on the right side are placed the switches for the pump motors and motor operated valves. The dimmer switches are placed near the group of light switches that they control. Each group of switches has an indicating light (of the telephone switch board type) showing the color of the circuit it operates while each switch has a pilot light showing when it is off or on. The dimmers are divided into three groups so that the water curtain or the stage fountains or the Upper Basin fountains may be operated separately and all circuits of each color on the stage and upper basins are under a master switch so that various color

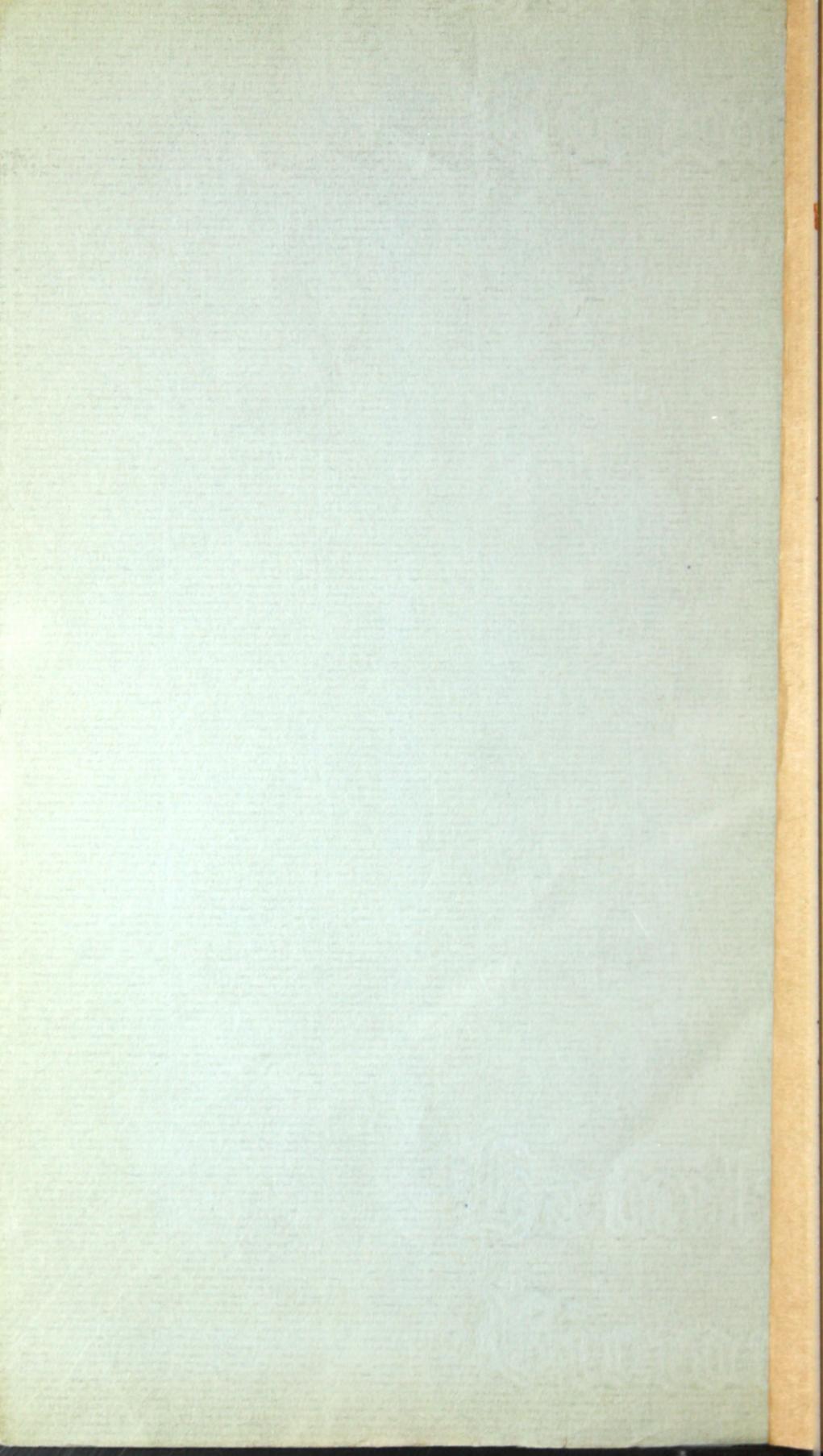
combinations may be prepared and turned on as a whole. Also to prepare these color combinations it was considered necessary to know at all times the exact position of the various dimmers and to do this a series of three indicating lights operated by sliding contacts geared to the moving parts of the dimmers was developed by the Cutler-Hammer Mfg. Co., from our ideas and suggestions.

The tearing out of the old and the rebuilding of the new theatre together with the installation of the above described apparatus required more than a year of time in work and thought, and it might be interesting to read a partial list of material used. More than 3500 feet of various sizes of brass pipe and 2200 brass fittings; more than a mile and a half of conduit and more than thirty miles of wire if measured in a single strand were used. There were 130 magnetic contactors; 175 single pole toggle switches; 720 special Kirby lites in addition to the transformers and dimmers above mentioned.

The installation of all of the pumps and piping was done by the plumbers of the Construction Division while the installation of the electric apparatus was done by regular electricians of the Maintenance Department, Charles Ruoss and John Griel, and their helpers, William Carter, Jr., and William Smith, together with such outside help as was necessary to complete the volume of work by the fifteenth of September, 1927. On the evening of this date the fountains were operated in their entirety before a gathering of about 1200 guests at a garden party.







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